

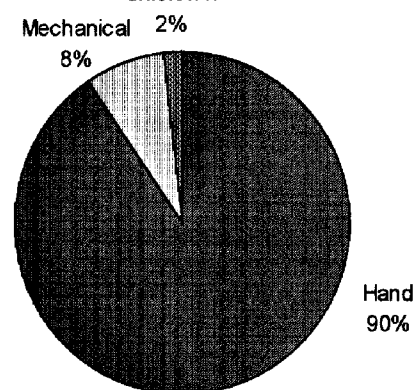
SCALING ROOF ACCIDENTS IN UNDERGROUND LIMESTONE MINES

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Scaling operations represent one of the most dangerous and most labor intensive operations in underground limestone mines. This paper provides some basic information on scaling accidents. Long-term objectives are to reduce scaling accidents. This will be accomplished by obtaining more information concerning scaling accidents, and by eventually characterizing conditions that are related to scaling and the role of scaling in the mining cycle. Miners depend on a roof and rib that has been scaled efficiently and properly for safe work conditions. Likewise, the scaling quality also affects the effectiveness of other support structures. For instance, proper scaling ensures adequate contact is established between bolts and stable roof and rib rocks.

Scaling accident information from underground limestone mines was obtained by the National Institute For Occupational Safety and Health (NIOSH) and from the Mine Safety and Health Administration records on ground control type accidents. The records showed that 201 ground control related accidents occurred from 1984 to 1994. About one-third of these accidents are related to scaling. There were 11 fatalities associated with the ground control accidents, one of which involved a scaler in a boom type scaling machine. The information quantifies accidents during scaling operations which lead to several safety suggestions. *First, scaling is generally safer using a scaling machine.* Over 90% of the scaling accidents occurred during manually scaling as shown in figure 1. The scaling machine usually adds some distance between the unstable rock and the worker. The worker is relieved of the physical exertion of manually scaling a roof and the dangers associated with that task. The scaler is, however, in control of a machine that is capable of exerting enormous force to bring down stubborn loose rock. Although accidents were substantially reduced using a mechanical scaler, the one fatality that occurred while scaling was related to a scaling machine and a large rock fall. A noteworthy

Severity of Scaling Accidents

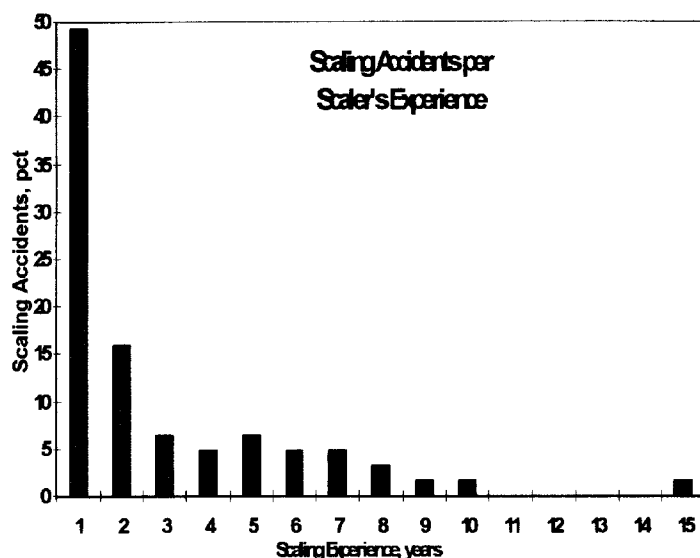
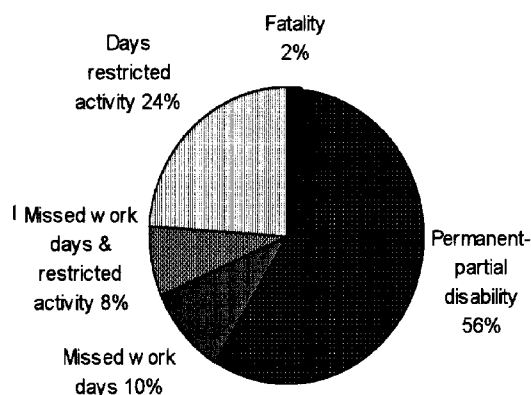


made by developing or using protective equipment designed for the scaler. The equipment could reduce injuries particularly for arms, fingers, legs, and feet. Arm and leg padding, such as worn by athletes, may be one way to cushion a blow from falling rock and also lessen the accident severity. A small investment in off-the-shelf protective equipment could potentially improve safety conditions for the worker and benefit the bottom line in lowering worker compensation costs.

advantage of the manual scaler is they can "sound" the roof and identify the extent and location of any cracks or loose roof rock. These highlighted areas can be periodically inspected by roof control technicians.

Second, limestone scaling accidents are seldom fatal, however, slightly over one-half involved permanent-partial disability. Extremities and limbs were the body part injured in nearly one-half of the accidents. The severity of scaling injuries are shown in figure 2. Reductions in injury severity could be

Severity of Scaling Accidents

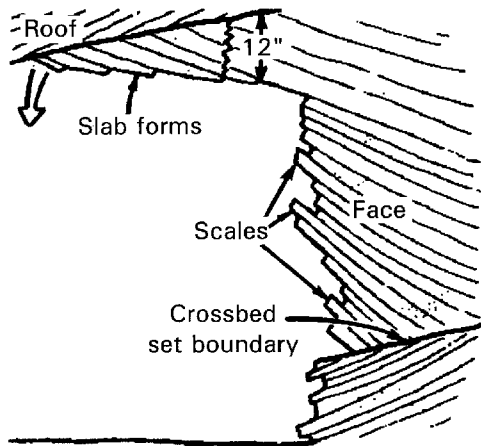


Third, one important aspect of all these accidents is the avoidance of accidents by proper training. In conversations with various limestone mine operators throughout the country, many have expressed interest in scaler training. This point is further emphasized by figure 3. The data indicates that the frequency of scaling accidents is directly proportional to miner scaling experience. Scaling is both an art and a technique. Although experience is gained only through time, this

information indicates that training, as well as defining proper scaling techniques, might play an important role in reducing injuries while scaling.

Two other factors noted in field work aligned with promoting scaling safety is knowledge of geology and blasting practices. These two factors may increase safety by reducing the amount of scaling that is necessary and thus decreasing the time the worker is exposed to the hazardous work. Loose rock is more likely to develop in certain types of geologic conditions.

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Discontinuities such as cross-set boundaries, as shown in figure 4, or the presence of bedding planes can result in more loose roof rock development. These bedding planes often contain clay or mudrock which further promote separation. However, it is possible that the bedding planes can be worked to the advantage. Proper blasting techniques on bedding planes that are oriented correctly will result in a smooth roof horizon. Poor blasting practices can lead to loose roof rock formation. Hanging and uneven rock left over from burnholes and rock damage from overbreak promote loose rock. Maintaining the proper roof horizon and proper blasting techniques will reduce the need for scaling which is a beneficial long-term effect.

In summary, this information presents the introduction of an effort by NIOSH to reduce scaling accidents in the limestone industry. The engineering design to match the appropriate geologic, stress, or mining factors is necessary. Combined with appropriate scaler training and redesigned equipment, scaler safety will be improved. A concentrated effort in this direction behooves all those involved in the underground limestone mining industry.